ONTARIO

DEPARTMENT
OF
EDUCATION

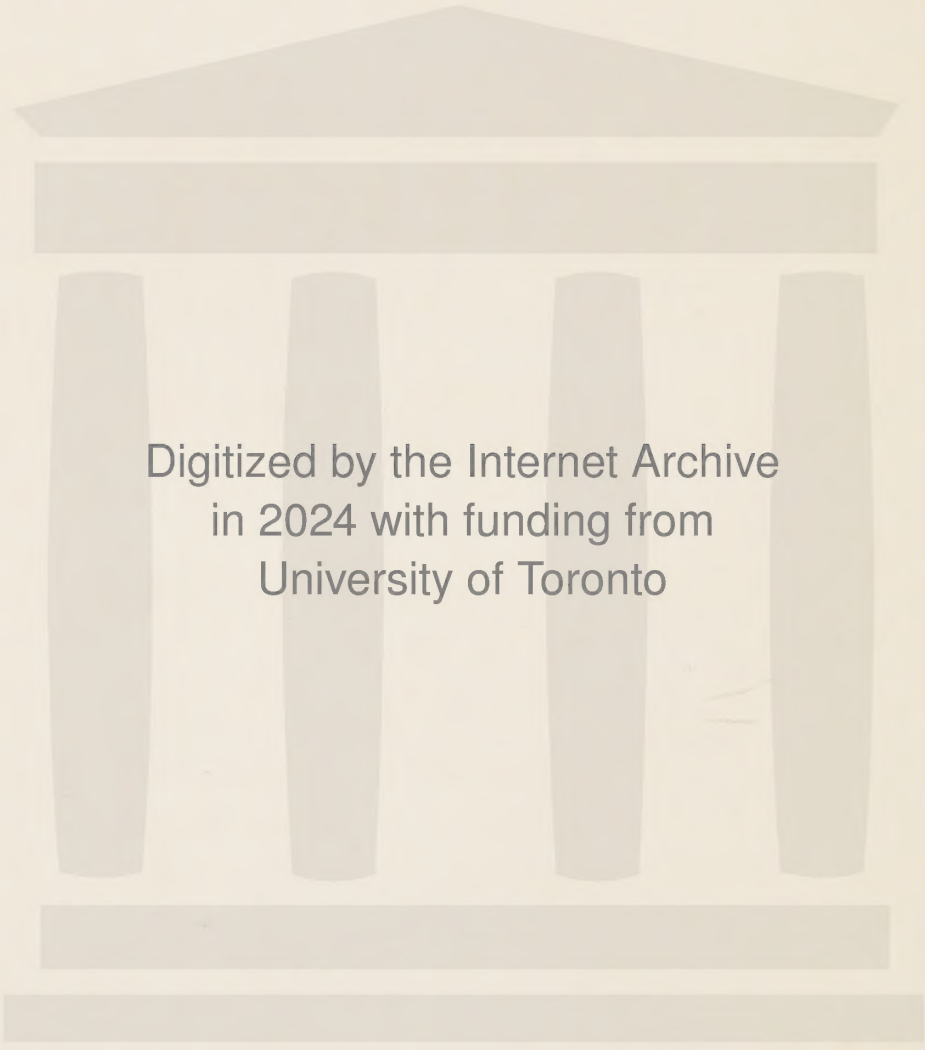
INTERMEDIATE DIVISION

SCIENCE

GRADES 7, 8, 9 and 10

CURRICULUM I:1(e)

1961



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ONTARIO

SCIENCE

INTERMEDIATE DIVISION
GRADES 7, 8, 9, and 10

(To replace existing courses in Science
in Curriculum I: 1)

First printed for introduction in
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1961

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SCIENCE

GRADE 7

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SCIENCE

AIMS

The aim of the course is to contribute to the healthy growth of the pupil, from childhood to citizenship in a democratic community, by using the materials, methods, and attitudes of science. Knowledge is a necessary step towards the attainment of the objective, but knowledge itself is not the principal aim nor is it an end in itself. The teacher of science aims to develop a person who will possess:

1. An understanding of the natural environment of man so that he will appreciate its complexity, its order, and the need for conserving natural resources;
2. Desirable attitudes of mind — especially curiosity, suspending judgment, tolerance, willingness to be convinced by evidence, looking for natural causes and the connection between cause and effect;
3. An appreciation of the scientific approach to problems, making and recording observations, formulating and testing hypotheses, keeping an open mind until there is sufficient evidence to warrant a sound conclusion;
4. Good habits of work and of oral and written expression, especially accuracy, organization, and conciseness;
5. Good health habits;
6. An interest in reading the literature of science, in conducting hobbies, in exploring the branches of natural science, and in discovering the applications of science to work and life;
7. The ability to do simple tasks that require a knowledge of practical science in the home, in the garden, and on the farm.

ORGANIZATION

The course as outlined is an attempt to provide a good foundation for pupils who will go on to further studies in science in the higher grades. At the same time it is intended to offer, for those who leave school at the end of Grade 10, an opportunity to learn something of the discoveries, the content, and the problems of as many fields of science as possible.

The wider dissemination of scientific knowledge by all the media of mass communication and education means that younger pupils are becoming familiar, even if only superficially, with many aspects of

modern science. The interest that has been thus aroused makes many topics teachable, and their teaching imperative, which formerly were thought to be suitable only for more mature minds. If advantage is not taken of this immediate interest, golden opportunities are lost.

With the ever-increasing expansion of scientific knowledge, there is an inevitable pressure to move more and more of the traditional elements in each field of science down into the secondary school and indeed to move some of the preliminary lessons into the elementary school. With the pupils' greater awareness of their environment, it no longer seems strange to find the beginnings of Physics or Chemistry, Astronomy or Geology, assigned to children who are not yet in their teens. Such a transition appears, indeed, to be inevitable.

Objection is sometimes made by science instructors in secondary schools that the teaching of topics in physical science in the elementary grades robs their subject of its freshness. Teachers of the lower grades are likely to reply that they are dealing with topics that are interesting to their pupils, who cannot be expected to wait three or four years to have their curiosity satisfied. It is possible that the loss of novelty or freshness that the one group complains of can be avoided by using a different approach in the elementary grades. By confining the study there to what can be properly and adequately done and by avoiding technicalities and incomprehensible explanations, the immediate needs of the younger pupils can be satisfied without giving them the feeling that the subject is exhausted or that it is too difficult for anyone to understand.

The emphasis in these courses has been properly placed on the experimental approach to new topics and the scientific investigation of natural phenomena. There are such wide divergences between schools in the matter of accommodation and equipment, between teachers in their interests and backgrounds of knowledge, and between geographical areas in their flora, fauna, and physical features, that there must always be local adjustments to meet local situations. Time allotments may vary slightly from school to school, but there must be a definite allocation of time for science in every school time-table and an honest effort to make proper use of the science periods. Every school can make some provision to meet the need for special equipment though again there are likely to be differences in this minimum provision of apparatus and supplies. There is a great opportunity for invention and ingenuity since much equipment can be improvised. Indeed the improvisation of apparatus is no small part of the proper training of a scientist. It is important that a part of every unit provided for a grade should be studied in order to acquaint pupils with the general character of each of the sciences. There is no intention of requiring the completion of every unit. Sections

marked with an asterisk are optional, and local considerations may necessitate further adjustments in the course. Since the course for the Intermediate Division is planned as a unit, it is imperative that the teachers of Grades 7 and 8 examine carefully the courses outlined for Grades 9 and 10. This should help them to plan their own teaching so that they will lay the necessary foundations for the work in the higher grades. At the same time it will help them to determine the amount of detail that is necessary and prevent them extending their courses into areas that ought to be reserved for the later years. In the same way, teachers of Grades 9 and 10 should look carefully over the syllabus for Grades 7 and 8 in order to know what may be expected of their pupils and to be able to avoid unnecessary repetition and the resultant waste of class time.

In vocational courses in Grades 9 and 10, these suggested courses in science may be used, stressing the technical application of principles involved, or the science courses for Vocational Schools (Curriculum I. & S. 27) may be used.

SCIENCE NOTEBOOKS

Training in science automatically requires training in accurate recording of work attempted and clear expression of conclusions reached. For this reason, the keeping of a proper notebook is an integral part of the science course, and the teacher of science must be prepared to give careful attention to it.

The notebook must, of course, be the pupil's own record, not a set of notes copied from the blackboard or dictated by the teacher. It must be accurate and neat and show evidence of clear thinking on the part of the pupil. The opportunity that it provides for practice in writing clear, concise English must not be wasted by substituting blank-filling exercises, which make very little contribution to the learning process, for unified, coherent, and objective exposition. Nor should the spirit of objectivity be lost in time-consuming decorating and embellishing, which too often serve only to mislead the pupil, or his parents, into thinking that he is doing homework.

The science notebook should be the thoughtful record of work done by the pupil himself. Requiring him to write a record of something that the teacher has demonstrated and to write it as if he had done the experiment is a practice of very dubious honesty. And requiring him to fit every notebook record into a single pattern instead of guiding him to formulate his own clear account of an experiment can lead to a false idea of the meaning of science and the reason for carrying on experiments. Not every lesson can be the occasion for an experiment, and not

every experiment can or need be written up in a stereotyped pattern of purpose, apparatus, procedure, observations, and conclusions. Many experiments are too incidental to require a formal record. Many others can be completely recorded by well-drawn, properly labelled diagrams, and making such diagrams, of course, provides practice in another very useful form of expression.

In stating the purpose of any experiment, care is needed. It is legitimate to experiment on the properties of air or the effect of carbon dioxide on limewater. On the other hand, to say that an experiment is being done to show that air has weight or to show that carbon dioxide turns limewater milky is to give away in the statement of purpose the whole set of facts to be observed or conclusions to be drawn. The actual manner in which an experiment is recorded, then, requires great care if it is to reflect correctly the scientific attitude that the science lesson should be developing in the pupil.

The development of this attitude can be encouraged by being certain that, in addition to records of experiments, the notebook contains data collected and tabulated by the pupil, with his own interpretation of their meaning, his own summaries of facts that he has learned and that he considers to be worth preserving, his own solutions of problems, and his own collection of pertinent illustrative material gathered from outside sources. Naturally, all of these records should be examples of the kind of systematic arragement and clear statement that mark good scientific writing.

Since a number of projects and topics suggested in these courses — for example, observation of the sun or the moon and the study of the weather — require observations to be made over an extended period of time, an important part of the work will be the making of records at intervals over a week or a month or throughout the whole school year. Careful preparatory planning in the classroom will be required to decide what data are to be collected and how they are to be recorded and tabulated. The responsibility for making the observations and keeping the records should be placed on the pupils, individually or in groups. This in itself constitutes a useful exercise, illustrating the scientist's way of collecting data before attempting any explanation or generalization. The last stage in the process, the examination of the data and the development of explanations or conclusions, should never be neglected. It provides the satisfaction that justifies the time devoted to the project and it furnishes the clearest illustration of the scientific process.

Any attempt to train pupils in the scientific method, however, is spoiled if the pupils are given answers that they might reasonably be expected to find for themselves; if they are allowed to be careless in measurement, inaccurate in recording results, or inexact in describing

their work or stating their conclusions. It is, for example, manifestly absurd to pretend, or to allow pupils to pretend, that in a few simple experiments they have proved any physical or natural law. Simple experiments may illustrate or demonstrate the meaning of the laws of reflection of light or Archimedes' Principle or Boyle's Law, but they do not prove them. And a notebook that offers the conclusions of these experiments as proof of such laws is a poor example of scientific reporting.

Pupils must learn respect for the precise use of language in scientific statements. Accordingly, they should reach, at any early state, some elementary idea of the nature of scientific proof or of what lies behind the development of a so-called law. Darwin travelled all round the world and then worked for twenty-five years observing, examining, and comparing before he felt justified in putting forward his theory "On the Origin of Species by Means of Natural Selection." But pupils should also learn to appreciate the fact that scientific laws and definitions are not necessarily fixed and immutable. Newton's laws seemed to have said the last word on gravitation until Einstein, centuries later, suggested the need for certain modifications. The definition of a chemical element had every appearance of finality until the work of Rutherford opened up the way to atomic fission.

The teacher must, then, plan very carefully and must prepare the pupils for the work they are expected to do and the records they are expected to keep. Since each subject has its own characteristic vocabulary, he must make special preparation in the field of expression and communication. The kind of descriptive writing that the scientist does is different from the geographer's or that of the fiction writer, and some preliminary consideration and training will be necessary. Providing the training for such writing is one of the most important responsibilities of the teacher of science.

There are, moreover, methods of study that are peculiar to individual subjects, and here again preparatory work is needed, if the notebook is to furnish a satisfactory basis for such study. Obviously, then, for its important rôle in the science course, the notebook must be carefully thought out and planned in advance and must, of course, be systematically checked by the teacher throughout the year.

All these things are essential if the pupils' notebooks are to perform their proper function, serving not merely as efficient auxiliaries to the science course but as indispensable vehicles for training in the scientific method. As such, they will also contribute to the general development of good work habits and will assist in establishing a permanently valuable attitude to learning.

PLANTS, THEIR STRUCTURE AND USES

1. THE PARTS OF A PLANT AND THEIR FUNCTIONS

Division of the plant into root, stem, leaves, flower; seeds and new plants.

(a) Roots

The removal of the soil from the roots of a plant by careful washing to show the complexity of the root system. An examination of the roots of weeds and of common field and garden plants, dandelion, corn, clover, beans, etc., to identify the primary and secondary roots and the root-hairs and to determine whether the systems are tap or fibrous.

Practical work on the functions of roots.

(i) The root of a complete plant placed in a bottle containing water; the bottle sealed around the stem with plasticine to prevent evaporation from the water surface. Observations of the water level over several days.

(ii) The tips of two parsnip roots cut off and the roots allowed to stand overnight in diluted red or green ink or food colouring. An examination of a cross-section of one and a longitudinal section of the other to determine movement of fluids.

(iii) A pocket garden (seeds of bean, radish, flax, etc., placed on absorbent material between two glass plates standing in a saucer of water) used to show the development and the purpose of root-hairs.

The anchorage, absorptive, and storage functions of plant roots, and their importance to the plant.

(b) Stems

Examination with a hand lens of a section of an herbaceous stem of some of these plants to identify epidermis, bundles, and pith.

Practical work on a function of stems.

(i) Cornstalks, celery, twigs of willow or poplar, or plants of wild carrot (Queen Anne's Lace) allowed to stand in diluted red or green ink for several hours and then examined in cross-section.

The supporting, transporting (food, minerals, water), and storage functions of stems, and their importance to the plant. Examination of a few stems of weeds, field plants, and garden

plants, such as golden-rod, corn, tomatoes, zinnias, maples, potatoes, strawberries, bindweed, morning glory, leading to a classification of stems as herbaceous and woody, and their habits as erect, running, or climbing.

(c) **Leaves**

*Observation of leaves of common plants and trees (grasses, corn, elm, ash, maple, horse chestnut, clover and some common house plants).

*Classification by shape as simple and compound. Identification of blade, midrib, vein, petiole, leaflet. Examination of veining to distinguish net-veining and parallel veining.

*A leaf collection. (See also Unit VIII, 1 (a).)

*Identification of trees by leaf-shape. (See also Unit VIII, 1 (a).) Practical work on the functions of leaves.

(i) A leaf of a growing plant inserted in a clear plastic bag or in a dry bottle or in a test tube having the mouth of the container plugged with cotton and supported. The plant and its enclosed leaf placed in a warm window and observed.

(ii) A potted plant in a dark cupboard for 48 hours. A leaf clipped from the plant, placed in boiling alcohol (Caution!) until white, washed in lukewarm water, and then dipped in iodine solution.

(N.B. Do not boil alcohol over or near an open flame or heater. The vessel of alcohol should be heated in a larger container of boiling water.)

The same plant allowed to stand in the light for an hour, and a leaf clipped and tested as before. Compare the two leaves and explain the difference.

(iii) Simple experiment on the movement of leaves in relation to light.

The functions of the leaf in transpiration (excess water), respiration (oxygen and carbon dioxide), and the manufacture of food (photosynthesis). The significance of leaf arrangements and movement.

*(d) **Flowers**

No detailed study of structure. (A study of the flower is reserved for Grade 8.) Recognition of the flower as a seed producer.

*(e) **Seeds and New Plants**

Why plants produce seeds. (Germination of seeds constitutes Unit VII. Spring Term.)

Practical work on other methods of plant reproduction.

(i) Planting (in water) tops of carrot, parsnip, and beet roots, or a piece of sweet potato.

(ii) Planting (in water) cuttings of stems of geranium, willow, leaf of African violet.

(iii) Planting (in soil) bulbs such as daffodil, narcissus, hyacinth, onion.

*2. PLANTS AND THEIR RELATION TO MAN

The uses of plants to man.

(a) **Food**

(ii) Examination of oats and rolled oats, or potatoes and potato flour. Testing for starch with a weak iodine solution.

(ii) Testing peanuts or walnuts for oil by the grease-spot test on unglazed paper.

(iii) Taste test for sugars in honey, maple syrup, tree sap.

(b) **Clothing**

Examination of linen or cotton fibres by means of a hand lens or a microscope. Reference to synthetic fibres made from plant material.

(c) **Shelter**

Examination of a small log to locate the outer bark, inner bark, sapwood, heartwood, pith rays.

Reasons why pine and spruce lumber are called softwoods and maple and birch are called hardwoods.

(d) **Fuel**

Reference to the use of wood and to coal as a fuel from prehistoric plants.

(e) Other plant uses — medicine, decoration.

(f) Indirect uses

(i) Reference to a food cycle, e.g., cattle and grasses.

(ii) The rôle of plants in soil anchorage, soil fertility, water retention.

WATER

1. SOME PROPERTIES OF WATER

(a) Changes of State

Simple demonstrations of the existence of water in three states — solid, liquid, and gas and of the ability to change from one state to another.

(i) The melting of ice as a process requiring the addition of heat.

(ii) Freezing of water by the removal of heat. The change of volume accompanying this change of state and its significance in the great force exerted. Application to rock weathering and soil formation.

(iii) Boiling and evaporation as changes from a liquid to an invisible gas or vapour, and requiring the addition of heat. The change of volume accompanying this change of state, shown by a rubber balloon tied over the neck of a vessel of boiling water. (Danger!) Significance of the force exerted. Steam engines.

(iv) Condensation as a change from vapour to liquid. Experiments to detect the presence of water vapour in the air by observing the outer surface of a glass or metal vessel containing ice-water. Water vapour in the breath.

(v) Changes directly from solid to vapour or from vapour to solid from observations on the drying of clothes hung outside in freezing temperatures; the disappearance of ice or snow from the sidewalk without melting; the formation of frost patterns on a window. The term sublimation. Other substances in which part of the sublimation process takes place. (e.g., mothballs).

(b) The Ability to Dissolve Materials

Practical work, tests, and experiments on the properties of solutions.

(i) Testing the ability of water to dissolve such solids as common salt, sugar, sand, baking soda. Evidences of solution and of limitations in the process. Appearance of a solution.

(ii) Testing the ability of water to dissolve other liquids such as oil, rubbing alcohol, antifreeze. Significance of this in the use of plain water as a cleaning agent.

(iii) Evidence that water can dissolve gases. A glass of water standing in a warm room. Soft drinks. The 'impurities' of water picked up from the air and the soil.

(iv) The differences between solutions and suspensions (fine clay, etc.). The effects of settling and filtering solutions and suspensions.

(v) Experiments to find out what happens to dissolved substances (solids) on evaporating or distilling. The distillation of salt water to give fresh water. Aeration to restore taste.

2. THE WATER CYCLE

(a) The reasons for the presence of water vapour in the air. Evaporation from land and water and ice surfaces. Water vapour in the breath. Reference to experiments on transpiration by plants.

(b) The removal of water vapour from the air. The conditions necessary to bring about condensation. The formation in nature of clouds, fog, mist; rain, dew; sleet, snow, ice.

(c) The water cycle as a process of continuous circulation.

*3. USES OF WATER

(a) Drinking. The local water supply — sources, impurities; purification processes — filtration, aeration, chemical treatment. Boiling or distillation for purification of small amounts. Springs and wells. Dangers and precautions in the use of untreated water.

(b) Washing. The effects of soaps and detergents. Simple experiments to test hard and soft waters by the action of soap. Hardness as due to the presence of soil constituents (lime) in solution.

(c) Plant growth. The intake of minerals from the soil and their transport through the plant (Unit I). The manufacture of plant food. Transpiration of excess water as part of the water cycle. Soil depletion by removal of soluble minerals. Water as a constituent of plant tissues, fruits.

(d) Animal requirements. Requirement as part of food intake, for digestive processes, elimination of waste products, temperature control by evaporation. The necessity of air dissolved in water for marine life.

HEAT

A simple experimental course in which much of the equipment can be improvised from household materials. In nearly all the experiments a common paraffin candle can be used as a source of heat if no other is available.

1. TRANSFER OF HEAT

The common sources of heat: sun, electrical energy, various fuels, friction, etc. The necessity for heat to travel, e.g., from sun to earth, from camp-fire to frying pan, from grate-fire to room, etc.

(a) **Conduction**

(Heat transfer through a substance or between two substances in contact)

(i) Experiments on the direction of heat movement, e.g., heating one end of a wire that has previously been coated with paraffin wax.

(ii) Experiments to compare rates of conduction in different materials, e.g., sterling silver and stainless steel teaspoons in a cup of boiling water.

(iii) Good and bad conductors of heat. Experiments to compare metals, glass, water, asbestos, etc. Practical applications of these results.

(b) **Convection**

(Heat transfer through a fluid (liquid or gas) by means of movements or currents due to a temperature difference)

(i) Experiments on convection currents in water, using colouring matter to show direction. Applications to cooking and to hot-water heating systems.

(ii) Experiments on convection currents in air, using smoke. Applications to hot-air heating systems, ventilation. The final stage of convection currents when temperature differences disappear.

(c) **Radiation**

The radiation of heat from a light bulb, detected by the hand. Differences between conduction, convection, and radiation. Radiation from the sun; the effect of interposing (i) glass, (ii) opaque materials. The importance of radiation.

*Vacuum flasks in relation to conduction, convection, and radiation to see why they are effective.

2. CHANGES IN VOLUME DUE TO HEAT

(a) Experiments with a flask, stopper, and long glass tube (bottle, drinking straw, and plasticine) to find the effect of heating and of cooling on the volume of air.

(b) A similar experiment with a flask filled with water to find the effect of heating and of cooling on the volume of a liquid.

Relation of these experiments to convection currents in water and air.

(c) Experiments to find the effect of heating and of cooling on the volume of a solid. The importance of these effects. Provision for expansion in railway lines, bridges, sidewalks.

*(d) Experiment with a bimetallic bar to test the differences in the temperature effect on different materials. Application of this in oven-thermometers, heating-system thermostats, dial-type thermometers.

3. MEASURING TEMPERATURE

The difference between temperature and quantity of heat; the need for fixed points for comparison, the commonly used ones being the freezing point and the boiling point of water.

(a) Examination of a Fahrenheit thermometer

(i) to note the numerical values assigned to the fixed points and the marking of the scale, and

(ii) to consider the reasons for the large bulb, the small bore, and the use of mercury or coloured alcohol.

*(b) Comparison of several thermometers for accuracy.

*(c) An examination of as many types of thermometers, including clinical and maximum and minimum thermometers, as can be assembled.

*(d) Use of the thermometer in keeping a record of hourly or daily temperatures, or classroom temperatures.

*Preparation of a table of important fixed temperatures.

GRADE 7. UNIT IV

MAGNETISM

This unit should be treated as a piece of scientific experimentation, differentiated from simply playing with magnets by making each experiment a purposeful investigation, by keeping simple records of the results of each experiment, and by the accurate statement of results and legitimate conclusions.

The work on magnetism is ideal for teaching or bringing home to the pupils the nature of scientific investigation, some features of which are listed here for consideration: the formulation of a problem; the recall of past experience; the consideration of various possible solutions; the selection of a hypothesis; the working out of a possible line of attack; the improvisation of apparatus; the establishment of controls; the experiment and careful numerical measurement; the repetitions to check accuracy; the repetitions under varied conditions as further checks; the search for possible exceptions; the keeping of accurate records; the drawing of conclusions stated in scientific language and carefully limited to what may be justified by the observations made; the finding of explanations for any exceptions noted.

Lack of elaborate apparatus need not be a hindrance since this is a field in which improvisation is easy. If necessary, a single magnet can be used to create other magnets out of needles (sewing, darning, or knitting) or any small pieces of steel. If compasses are not available, they also can be improvised out of magnetized needles, with the pupils using their ingenuity to find ways of floating or otherwise suspending them.

1. EXPERIMENTS ON MAGNETIC PROPERTIES OF MATERIALS

(a) Testing with a magnet as many substances as possible, making lists of magnetic and non-magnetic materials.

(b) Examination of several kinds of magnets — steel, magnetic alloys, and natural magnets (magnetite or lodestone).

(c) Making a magnet by rubbing a piece of steel with a magnet. Difference in effect on iron (nail) and steel (needle).

(d) Improvising a magnetic compass.

(e) The magnetic compass as an instrument to test for magnetism.

(f) The effect of interposing sheets of different materials (glass, aluminum, paper, iron, etc.) and different thicknesses between a magnet and a compass needle.

(g) (h) (i), etc. Experiments suggested by pupils.

2. EXPERIMENTS ON POLARITY

Experiments with freely-suspended bar magnets.

(a) Establishing and marking the north-seeking and south-seeking ends or poles, and

(b) Finding the effects of the marked poles on each other and on compass needles.

Discussion of how a scientific law is established, by the evidence of a great many experiments without any unexplainable contradictions. The rule or law of polarity as derived from experiments suggested above.

*3. MEASURING THE FORCE OF A MAGNET

(a) Preliminary discussion of the nature of a force, in simple terms.

(b) Using the number of tacks or paper clips that can be suspended as a measure of magnetic force.

(c) Using this device to measure magnetic force at different points along a magnet.

(d) Bringing a magnet slowly toward a compass to measure the distance at which an effect is first noticed. Trying this in different directions.

(e) Experiments to determine how the strength of a magnet is affected by using it to make other magnets.

4. EXPERIMENTS ON LINES OF MAGNETIC FORCE

(a) Sprinkling iron filings on a paper spread over a magnet. Introduction of the terms *magnetic field* and *lines of magnetic force.*

(b) Moving a small compass around within a magnetic field and observing the position of the needle relative to the lines of force.

*5. THE EARTH AS A MAGNET

Discussion of the experiments in 2 and 4 above with the assumption that the earth is a large magnet; the earth's magnetic field and lines of force; the geographic and magnetic poles. Why the compass needle does not indicate true north.

*6. MAGNETIC THEORY

(a) Experiment, breaking a magnetized knitting needle into two, four, and eight pieces and testing the polarity of the ends of each piece.

(b) The arrangement of magnetic particles suggested by this experiment. Magnetization by rubbing with a magnet. Magnetization in the earth's magnetic field.

(c) Keeping pairs of magnets with poles reversed. The use of keepers. The significance of these procedures.

GRADE 7. UNIT V

ROCKS, MINERALS, AND FOSSILS

This unit should be closely linked to the geology of the local area. It is possible in most parts of Ontario for pupils to become familiar with a wide variety of rock types and to make collections of rocks within a short distance of the school by examining roadside and fence-corner stone piles.

In some areas, collections of minerals or of fossils are easily made. Collections of 36 mineral chips or 36 rock chips can be purchased for $1.00 for each collection from the Geological Survey, 601 Booth Street, Ottawa, or a collection of minerals and rocks is obtainable from the Department of Mines, Parliament Buildings, Toronto.

1. RECOGNITION CHARACTERISTICS OF ROCKS AND MINERALS

Examination of a variety of rocks and minerals for

(a) Colour: Limestone, several sandstones, several granites, quartz, pyrite, etc.

(b) Lustre: Some examples of glassy, pearly, silky, metallic, earthy, and waxy lustres. (N.B. In examining rocks for either colour or lustre it is advisable to examine a freshly broken surface.)

(c) Hardness: Simple tests such as the ability to scratch, or to be scratched by, a finger nail, a copper coin, a knife blade, a quartz crystal.

(d) Fracture and cleavage. Rocks that split in layers (shale, mica). Rocks that break along two or three planes (feldspar). Irregular fracture (granite, quartz).

*(e) Existence of crystals. Recognition of a crystal as possessing flat faces, straight-line edges, characteristic angles. Practical work on crystal growth by the slow evaporation of solutions of common salt, sugar, alum, bluestone (copper sulphate) to show characteristic forms.

*(f) Existence of fossils. Recognition of a few types of local fossils, if any.

Identification of such common rocks and minerals as quartz, feldspar, micas, granite, gneiss, limestone, shale, slate, sandstone, calcite, marble, iron and copper pyrites, magnetite (in sand), and other locally available minerals and rocks.

2. CLASSIFICATION OF ROCKS

Simple classification of rocks into sedimentary, igneous, and metamorphic, or altered, rocks. Examples of each class and discussion of the mode of formation and resultant characteristics, such as the layered structure of the sedimentary rocks, the melted or stirred-up appearance of the igneous rocks, and the differences between the original material and the altered form of the metamorphic.

3. LOCAL ROCKS AND MINERALS

The bed-rock of the locality; its classification; the significance of its origin and occurrence or exposure here; the significance of any crystals or fossils in it; the significance of the presence of 'foreign' rocks in the vicinity; other evidences of glaciation in the vicinity; the significance of any special topographical features of the area.

*A study of the use of local rocks, minerals, or materials; mines; quarries, brick and tile works, other building materials, oil, gas, etc.

*Making a collection, individual or for the school, of rocks and minerals, either general or related to a limited area around the school. A collection of fossils.

*An examination of samples of sand collected from lake and river beaches, gravel pits, etc., using a microscope or hand lens and a magnet and trying to identify as many constituents as possible.

*(This topic may be reserved for fuller development in Grade 8, Unit VII.) An examination of soil samples to identify as many rock constituents as possible. Shaking up a quantity of soil with water and allowing it to settle in order to determine the existence in the soil of humus or vegetable matter. Filtering some of the water and allowing it to evaporate in a glass dish to test for the presence of soluble material in the soil. (N.B. If distilled water is not used in this experiment, a good opportunity is provided to discuss the use of controls in experimentation since obviously another dish of water must be evaporated under similar conditions to validate the experiment.)

GRADE 7. UNIT VI (a)

MILK

MILK

A practical study of milk (whole milk, not homogenized).

(i) Physical characteristics: colour, taste, appearance (including examination under a microscope if possible). Observations on milk standing in a tall glass cylinder; the amount of cream.

(ii) The constituents separated and tested simply:

(a) grease spot test for butter fat, (b) separation of the skimmed milk into curds and whey by the addition of vinegar or rennet; filtering off the curd (casein), test by burning (odour); (c) heating some skim milk till a skin forms (albumin); (d) slow evaporation of whey (milk sugar and minerals).

The importance (as a food) of each constituent of milk. Reference to vitamins in milk. The perfect food.

(iii) The effect of pasteurization. Some raw milk divided into two portions (control). One part pasteurized, then both kept at room temperature and examined from time to time. The importance of pasteurization. Pasteurization laws. Precautions by producers, distributors, and consumers in handling milk.

GRADE 7. UNIT VI (b)*

*FARM ANIMALS

The ways in which man has improved the breeds of livestock. The significance of the terms, purebred, grade, scrub animal.

1. CATTLE

Classification as dairy, beef, and dual purpose types.

(a) Dairy cattle. Characteristics of Holstein, Jersey, Guernsey, and Ayrshire breeds.
The characteristics of a good dairy cow.
The importance of the dairying industry and the means whereby it is improved or maintained.

(b) Beef cattle. Characteristics of Shorthorn, Hereford, and Aberdeen Angus breeds.
The characteristics of good beef cattle.
The location of the various "cuts" of beef.

(c) Dual purpose cattle. Characteristics of English Shorthorn and Red Polled breeds.

2. HORSES

Classification as draft and light types.

(a) Draft horses. Characteristics of Clydesdale, Percheron and Belgian breeds.
The characteristics of a good draft horse.

(b) Light horses. Comparison of light and draft horses. Significance of the term "thoroughbred".

3. PIGS

Characteristics of the Yorkshire breed as a bacon hog.

4. SHEEP

Characteristics of the long-wool mutton types.

5. POULTRY

Characteristics of several breeds of chickens found on Ontario farms.
Examination of an egg to show structure and parts.
Practical work on candling eggs and grading by weight.
Practical work with an incubator.

GRADE 7. UNIT VII

SEEDS AND SEED GERMINATION

1. THE STRUCTURE OF SEEDS

(a) Examination of bean seeds (white beans or lima beans) that have been soaked in water for a day. Location of the external parts — seed coat, scar, small opening — and their significance. Removal of the seed coat to observe the parts of the miniature plant between two cotyledons. (The use of the terms *hilum* for scar, *micropyle* for small opening, *plumule* and *radicle* for parts of the *embryo* is not recommended for this grade.)

(b) Examination of other seeds with two cotyledons and comparison with bean: peas, and squash or pumpkin.

(c) Examination of corn kernels that have been soaked in water to locate, by cutting the kernel lengthwise, the endosperm (food reserve), and the single cotyledon containing a miniature plant with its future leaves and root. (N.B. In referring to corn and the other grains listed below, the term *kernel* is preferable to *seed*, because the outer coat is technically not a part of the seed.)

(d) Examination, and comparison with corn, of kernels of wheat, rye, barley, or oats.

(e) Testing for starch in several of the seeds and kernels studied. The test gives better results if the seeds or kernels have been boiled in water and cooled before adding the iodine solution.

2. THE GERMINATION OF SEEDS

(a) The process of germination and the daily progress of development can be observed in a tumbler or drinking glass. A clean blotter or paper towel is rolled to form a cylinder fitting the inside of the glass; soaked seeds or kernels (peas, beans, corn, pumpkin) are pushed down between paper and glass; the inside

of the cylinder is filled with sawdust or coarse sand, which is kept moist. (As an alternative method, seeds may be planted in soil, sand, or sawdust, and one or more of the germinating seeds, or the seedlings, removed and examined at intervals of a day or two.) Daily observations and outline sketches may be made of the germination and growth.

(b) Experiments (with controls) improvised by the pupils to determine whether

(i) seeds will germinate if kept quite dry,

(ii) seeds will germinate if they have been exposed to intense cold,

(iii) seeds will germinate if they have been baked in an oven,

(iv) seeds will germinate if they are a number of years old, etc.

The structure and function of a seed, leading to a definition.

(c) **Growing New Plants**

The preparation of window trays, boxes, or flower pots of light soil. Planting tomato, petunia, snapdragon, zinnia, aster, and marigold seeds. Observation of the growth of these plants, their care including thinning and watering, and transplanting into school or home gardens when the danger of frost is over.

3. QUANTITATIVE GERMINATION TESTS

(Either Part (a) or Part (b) may be used.)

(a) Practical work with a plate germination test made by placing layers of blotting paper or paper on a large plate; twenty-five (or more) bean seeds placed between the layers, moistened, and covered with another plate. A daily record should be kept of the number of seeds that have germinated, and the percentage germination should be calculated. Other seed samples may be tested similarly, including commercial seeds intended for garden or field crops.

(b) Use of a rag-doll germination tester, a rectangular piece of cloth marked off into (numbered) squares; seed samples placed on the squares and the cloth rolled up and tied. The roll is allowed to stand in a jar in an inch of water. A record is kept of the percentage daily germination of each kind of seed.

FORESTS

1. IDENTIFICATION OF TREES

Developing the ability to recognize many of the trees of the locality or to distinguish between related members of tree families such as the maples, oaks, poplars, pines, in *several* of the following ways:

*(a) By leaves. Making a general collection or special collections by families or by classes (simple, compound, etc.).

(b) By flowers. Observing or collecting, identifying, pressing, and mounting the flowers of common trees. Making records of flowering dates.

(c) By fruits or cones. Distinguishing species of maples, oaks, or elms by their fruits or various evergreens by their cones. (N.B. Technically, acorns, hickory nuts, and the keys of maples, elms, and ashes are fruits. The seed is only a small part of the structure.)

(d) By bark. Observing and comparing the barks of several trees.

(e) By twigs. Examining twigs of several different trees to find distinguishing characteristics. Observing terminal and lateral buds, leaf scars, lenticels, and bud arrangement. Observing the development in water of cut twigs of horse chestnut or poplar.

(f) By woods. Observing the characters of woods, either by collecting and preparing specimens or by studying finished surfaces in furniture, flooring, panelling, and household articles made of wood — annual rings and other markings. Simple comparisons of weight, hardness, colour, grain, and their significance for different uses.

2. THE IMPORTANCE OF FORESTS

A discussion of the importance of forests from the scientific point of view in the light of experimental work and reference to relevant facts and experiments in previous units of the course.

(a) **Natural Importance**

(i) Retaining moisture. Simple observations on the melting of snow in shaded and sunny areas. Testing the evaporation of water from flower pots of soil kept in sun and in shade. Testing the amount of moisture retained after watering pots of sand and soil rich in humus. Water retention, surface run-off, flood control. Observations of

water run-off from sloping surfaces of bare and grass-covered soil. (This topic may be deferred to Grade 8, Unit VII. Soil.)

(ii) Building top-soil. Testing some soil from the forest floor for mineral matter and humus as in Unit V. Comparing the growth of seeds in pots of forest top-soil and in pots of ordinary garden soil.

(iii) As a shelter for mammals, birds, reptiles, insects with a forest habitat.

(iv) Recreational value.

(b) **Economic Importance**

A full treatment of this topic belongs properly to the study of Geography. The differences in the uses of hardwoods and softwoods; the bases of these differences, including rate of growth and the physical differences in the wood, are worth consideration.

3. FOREST PROTECTION AND RENEWAL

(a) Discussion of the damage done by forest fires, caused by (i) man, (ii) lightning. Methods of prevention.

(b) A study of the damage done to forest trees by insects and by fungous and other diseases. Some of the following that have local significance might be studied. (Forest tent caterpillars, white pine blister rust, Dutch elm disease, birch die-back, bracket fungi, spruce bud worm, larch saw fly.) Means of control.

(c) Discussion of the damage caused by wasteful cutting practices. Clear cutting and selective cutting. Observation of the differences between a protected woodlot and one used for pasture.

(d) The problems of reforestation (i) in recently cut areas, (ii) in waste lands. The work of provincial forestry stations (tree nurseries). County and township reforestation projects. Planting trees in the school grounds.

GRADE 8. UNIT I

FLOWERS, FRUITS, SEEDS

Well-planned outdoor lessons should be an important part of this work.

1. THE PARTS OF A FLOWER

(a) An examination and comparison of some of the following flowers and their parts: garden plants, such as morning glory, phlox,

snapdragon, nasturtium, salvia; and wild plants, such as touch-me-not, bouncing bet, or other fall-flowering plants with simple flowers. Recognition of stamens, pistil, petals, and sepals and of the variation in their form, number, arrangement, and attachment. The parts of the pistil (stigma, style, and ovary) and of the stamen (filament, and anther with pollen). Collection of green or ripe seed pods and opening them to observe structure and contents. Comparison of these containers with the pistil of the flower.

(b) An examination of one or two composite flowers and of their individual strap-shaped florets: chicory, dandelion, hawkweed, to identify head, floret, bract, pappus, and to establish the individual differences of the flowers examined and differences from those in (a) above. (Composite heads with both disc and ray florets will be studied in Grade 10, Unit I.)

*(c) Recognition of the meaning of the terms *complete* and *incomplete* as applied to flowers and the examination of a sufficient number of flowers to show the variety in the way the parts are combined.

2. THE FORMATION OF FRUITS

The significance of the parts of a flower in relation to the production of fruit or seed.

(a) Pollination as the transfer of pollen from anther to stigma.

(i) Self-pollination, e.g., by curling of stigma in dandelion;

(ii) Cross-pollination. Adaptations favouring cross-pollination by insects — colour, size, perfume, nectar, arrangement of flower parts. Adaptations favouring cross-pollination by wind — abundance and lightness of pollen, branched or feathery stigmas.

(b) Fertilization. The use of diagrams to illustrate the production of a pollen tube, its growth down the style and into the ovule, and union with the contents of the ovule.

3. SEEDS

(a) Collection and examination of seed-cases in several stages of development, to show growth and changes in the ovary wall and contents.

(b) Collection and examination of as many kinds of seeds and seed containers as possible and preparation of a display. Dry and fleshy fruits.

(c) The importance of seed production and seed dispersal to the plant. (It may be assumed that the topic, "Adaptations Favouring Seed Dispersal," will have been taught in earlier grades and need not be repeated here.)

*4. **SPECIAL CASES**

(a) Examples of flowering plants that depend on other means than seeds for survival, e.g., potato.

(b) Recognition that there are many classes of plants that do not produce flowers or seeds, such as ferns, mosses, mushrooms, moulds.

GRADE 8. UNIT II

THE ANIMAL KINGDOM

This is a comparative study intended to encourage the pupil to observe and recognize many common animals, to learn how these animals thrive in their own special surroundings, and to notice the characteristics that form the basis of the scientific classification of the animal kingdom. (N.B. Popular usage tends to restrict the word, *animal,* to the four-footed mammals. Pupils should become familiar with the word in its broader sense, as including invertebrates, as well as vertebrates, fish, reptiles, amphibians, birds, as well as mammals, and, of course, man.) Well-planned outdoor lessons should be an important part of this work. For classroom lessons, many species can be kept in aquaria, terraria, wire cages, or glass jars covered with wire mesh or gauze. Observation of living specimens should be the rule wherever possible. This is not intended as a text-book course.

This unit may prove to be too long for its completion with the necessary outdoor work in the fall term. If so, it would be advisable to divide the unit at the end of Section 2 and to transfer Section 3, "Animals with Backbones," to the Spring Term, where it could be very properly combined with the topics of Unit VIII, "Wildlife." (N.B. A more detailed study of these animals will be made in Grade 9. For Grade 8, the emphasis should be on observation of the living animal and its habits, leaving the study of body structure and functions to the later grade.)

1. **ANIMALS WITHOUT BACKBONES**

(a) Protozoans. Observation with the naked eye, a hand lens, or a microscope of the one-celled animals to be found in an infusion of hay or lettuce or in a dish of pond water. Reference to one

type of animal observed (paramœcium, etc.) as exhibiting movement (action of cilia), food-getting (oral groove), excretion, to show that processes observed in multi-celled animals can also be observed in single-celled animals.

(b) Molluscs. An examination of a slug or snail for external features. Movement and feeding can be observed if snails are kept in an aquarium to keep the glass clean. Method of breathing. The importance of clams, slugs, and snails.

(c) Worms. Observation of external features, feeding and burrowing habits, and the ways in which earthworms are suited to their environment. The importance of earthworms.

2. ANIMALS WITHOUT BACKBONES — ARTHROPODS

(A very large group of animals characterized by having an outside skeleton and jointed legs.)

(a) Spiders. An examination of a spider to see the two body divisions and four pairs of legs. Outdoor observations on webs and their construction or repair. Feeding habits. Egg sacs. Differences between spiders and insects.

(b) Millipede or centipede. Observation of one of these to see the exoskeleton, the jointed structure, and the many pairs of legs.

(c) Crustaceans. Examination of oniscus (pill bug or sow bug found under boards lying on the ground). Observation of a crayfish kept in the aquarium, to compare the external features including eyes and antennae, the feeding habits, and the methods of movement with Insects studied next. (A detailed study of the crayfish is undertaken in Grade 9, Unit V.)

(d) Insects.

(i) Observation of living insects: grasshopper, cricket, praying mantis, outdoors and in the classroom in a container supplied with grass-sod or a suitable host-plant.

A detailed study of one insect (N.B. If most of the pupils have studied the grasshopper in earlier grades, another insect should be chosen.) Moving, feeding, protection. An examination of the dead insect, including simple dissection with pins and a razor blade, to see sense, feeding, breathing, and locomotive organs.

(ii) Discussion of the life history of the insect studied in (i) above.

(iii) A shorter study of another insect (housefly, honey-bee, mosquito) to show differences in external features, feeding habits, and life history. Complete and incomplete metamorphosis.

*(iv) Making a list (or a collection) of common insects of the locality, classifying them as beneficial or injurious to man, plants, animals, household goods. Means of control of several injurious insects. The general characteristics of insects, variations in their habits and habitats, the reasons for their dominance, and their natural control.

*(v) The honey-bee as a domesticated insect.

Observation of bees kept in the classroom in small jars. Body structures of workers in relation to pollen collection and distribution. The operation of a single hive of bees and its care throughout the year.

3. ANIMALS WITH BACKBONES

(a) Fish. Observation of living fish in the aquarium, to note adaptations for movement (scales, fins, body shape), protection, breathing, feeding.

(b) Amphibians. Observation of a living frog or toad in the terrarium, to note its external features and methods of feeding, breathing, and locomotion. The life history and the general characteristics of the amphibians. Other members of the group.

(c) Reptiles. Observation of a living snake or turtle in the terrarium, to note external features and methods of feeding, breathing, and locomotion, life histories, and general characteristics of the group. Other members: lizards, alligators, crocodiles.

(d) Birds. The general characteristics of birds. Classification of birds on the basis of their feeding habits — seed-eaters, flesh-eaters, carrion-eaters, and insect-eaters. Classification on the basis of habitat — marshland, meadow, orchard, forest (hardwood and evergreen), lake, and river. Classification on the basis of residence — permanent residents, winter residents, summer residents, regular migrants, domesticated birds. Recognition of some birds of each type; recognition of special characteristics of size and shape, feet, legs, wings, beaks, coloration, and colour changes as adaptation for different modes of life.

*Establishment and maintenance of winter feeding stations.

(e) Mammals. The general characteristics of mammals (warm-blooded, the young born alive and fed on mother's milk). Classification of mammals on the basis of food, as insectivore, carnivore, herbivore. Observation or discussion of the characteristics of some of the wild and domesticated animals of the locality. Their adaptations to mode of life with respect to external features, locomotion, feeding, breathing. An understanding of such special animal adaptations as the paws of a cat, the quills of a porcupine, the fur of a bear, the absence of fur on an elephant, the trunk of the elephant, the snout of a pig, the long neck of the giraffe, the hoofs of a horse, the scent of a skunk, etc.

4. SUMMARY

(a) The similarities of plants and animals as living things, feeding, breathing, growing, reproducing, and reacting to their surroundings.

(b) The differences between plants and animals. There is actually no clear line of division, and there are exceptions to most rules. In general, however, animals have freedom of movement, and most animals feed on animal or plant material.

(c) Compilation of a list of the animals of the locality, grouped under the five classes of vertebrates: fish, amphibians, reptiles, birds, and mammals, with information tabulated under such headings as habitat, external features, food, breathing, locomotion, life history, special adaptations.

GRADE 8. UNIT III

ASTRONOMY

In this unit the emphasis should not be entirely on the theoretical or the descriptive side: as far as possible, experimentation and observation on the part of the pupils should be encouraged. There is an opportunity for useful exercises in observation outside the classroom and in keeping accurate records over an extended period. Some sections will require records planned and made in advance of the lesson.

1. THE SUN AS THE SOURCE OF LIGHT, HEAT, AND ENERGY

(a) Light. Recognition of darkness as the absence of light; the cause of shadows. Simple experiments leading to the conclusion that light travels in straight lines. Experiments with a prism to discover the presence of colours in light. The significance

of light — in a room into which the sun does not shine directly; on a cloudy day. Experiments on reflection.

(b) Heat. Experiment with a magnifying glass on the concentration of solar heat. Demonstration of the areas covered when a narrow beam of light falls on a piece of paper held

(i) at right angles, and

(ii) obliquely to the beam;

the significance of this in the heating effect of the sun's rays.

(c) Energy. The various fuels and sources of energy used by man and their relation to the sun's light and heat.

2. THE SUN AS THE CENTRE OF THE SOLAR SYSTEM

A diagram of the sun and the orbits of the planets, with some reference to size and distance in the scale of the diagram. The comparative sizes of the sun and earth. The earth's orbit as an ellipse, January and July positions. *Collection of information about the temperature of the sun, the source of its energy, sun spots, etc.

3. THE EARTH AND THE SUN

(a) Observations on the position of the sun at different times during a single day; at an exact time (noon) from week to week; at sunrise and sunset from week to week. A board covered with white paper placed on south window-sill; the shadow cast by the top of a darning needle, or the spot of light coming through a small hole in a cardboard covering the window, can be marked at intervals through the day or on successive noons. (Interesting results are obtained from the position of the noon shadows marked at monthly intervals through the year, or by hourly shadows marked on Sept. 21, Dec. 21, March 21, and June 21.)

(b) A demonstration with a flashlight or an unshaded light bulb and a rotating globe, to explain the cause of day and night.

(c) The position of the earth's axis

(i) in relation to the Pole Star,

(ii) in relation to the plane of revolution.

A demonstration with a globe moved around a source of light, to show the angles at which the light rays strike different parts of the globe. Reference to the heating effect discussed in 1 (b) above. The cause of the seasons, noting that these are contrary to what might be expected from the position of the earth in its orbit (section 2 above). Length of day and night.

(d) The earth as a timekeeper. Seconds, minutes, and hours as subdivisions of the day from one solar noon to the next (averaged) and weeks and months as subdivisions of the year from one solar position over the Tropic of Cancer to the next. Leap Year. Standard Time zones. *Official time signals. Astronomical measurements of time. Special clocks.

(e) Gravitation and the opposing action of solar gravitation and the earth's motion in its orbit.

4. THE MOON

(a) A moon calendar prepared in the month preceding this topic, showing the shape of the visible part of the moon and its direction and altitude in the sky at 8 a.m. or 8 p.m. daily.

(b) A demonstration with models and a light source, to explain the moon's phases and to account for the rising, apparent westward motion, the setting of the moon, the actual daily progression from west to east, and the later rising of the moon from day to day.

*(c) Tides and their relation to the moon's phases and gravitation.

*(d) Diagrams to show the causes of eclipses of the sun and moon. Umbra and penumbra demonstrated by standing a pencil vertically on a sheet of white paper near a bright window. *Collection of information about conditions on the moon, its surface atmosphere, temperature, etc.

*5. OTHER MEMBERS OF THE SOLAR SYSTEM

(a) Recognition of some of the planets as they come into favourable position for observation. Observation through a telescope or field glasses of the phases of Venus, the moons of Jupiter, the rings of Saturn.

(b) Diagrams showing the relative sizes and orbits of the planets. Their periods of revolution.

(c) Discussion of meteors, meteorites, asteroids, and comets.

*6. THE STARS

(a) Identification of some of the brighter stars and constellations: Big Dipper, Little Dipper, Cassiopeia, Pegasus, Pleiades, Orion, North Star, Vega, Aldebaran, Sirius, etc.

(b) Observation of the position of the Big Dipper several times in one evening or at a fixed time through the year or the study of monthly star maps to show apparent motion of the stars around the North Star. Relation to 3 (c) above.

(c) The measurement of distances to stars in terms of the speed of light; light years. The sizes of stars. Recognition of our sun as a medium-sized star.

(d) Collection of information about galaxies, the Milky Way, etc.

(e) Collection of information about some theories of the universe. The contributions of Ptolemy, Galileo, Copernicus, Newton.

(f) How astronomers have made discoveries about the universe, e.g.,
  (i) with the naked eye,
  (ii) with the telescope — Galileo and the moons of Jupiter,
  (iii) with the spectroscope — Frauenhofer and the sun's composition,
  (iv) with modern telescopes and cameras,
  (v) with rockets — the moon's other side.

GRADE 8. UNIT IV

AIR

A simple experimental course in which much of the equipment can be improvised from household materials.

1. SOME PROPERTIES OF AIR

(a) Simple demonstrations of the existence of air and its occupation of space —
  (i) Air becomes visible in the rising currents over a radiator or hot stove or when it is bubbled through water.
  (ii) Pushing a glass vessel, mouth down, into a dish of water.
  (iii) A balloon filled with air or an inflated tire offering some resistance to external forces. The compressibility of air.

(b) The weight of air. If facilities are available, the difference in weight of an empty and an inflated football or tire can be measured. Finding information on the weight of a cubic foot of air. Calculating the weight of air in the classroom.

(c) Air-Pressure.
  (i) Boiling a little water in a flat-sided can; removing from heat, replacing stopper of the can, and allowing it to cool.
  (ii) Repeating with other cans placed in different positions to see if there is any evidence of the direction of air-pressure.

(iii) Filling a glass with water, placing a thin card over the top, and inverting it. In what direction does air-pressure act? Relation of weight of air and air-pressure.

(iv) The effect of reducing air-pressure — in a fountain-pen filler, a vacuum cleaner, a drinking straw, a common pump.

2. AIR IN MOTION

(a) Air currents over heated surfaces — (i) visible movements, (ii) a disc of tin cut and bent into a series of fan blades, balanced on a pin point and held over a candle flame, or a cardboard disc cut into a spiral and balanced on a pin-tipped rod over a flame. Hot air balloons. Explanation of the rising air in terms of its expansion by heat and becoming lighter when equal volumes are considered.

(b) Convection currents in air (Grade 7, Unit III, 1 (b) (ii)) related to the rise of heated air as it is pushed up by cooler air. The lower horizontal movement of these convection currents as wind.

(c) Force exerted by air in motion. Windmills and sailing vessels. Damage by high winds in tornadoes and hurricanes. Sandstorms and blizzards. Sand blasting and other uses of compressed air.

(d) Resistance of air. Action of parachutes, falling leaves, seeds with keys and sails. Action of bird wings against air to provide both lift and propulsion. Electric fans, airplane propellers, and jet engines. Streamlining of airplanes and cars.

*(e) Motion through the air. The lifting action of airplane wings illustrated by blowing over a curved strip of paper. By investigation and experiment illustrate such terms as *lift*, *thrust*, *drag* in relation to the flight of a plane. The parts of an airplane and their rôle in flight: wing, aileron; stabilizer, elevator; vertical fin, rudder.

3. THE CONSTITUENTS OF AIR

(a) Oxygen and Nitrogen. A loose ball of steel wool, cleansed of grease by squeezing it in a solution of detergent and rinsing in plain water, placed in a straight-sided jar and the jar inverted in water for several days. The change in the steel wool is the formation of iron oxide by combination with the oxygen from the air.

The remaining gas is mostly nitrogen, and its difference from the original air can be established by inserting a blazing splint. Observation on the height of the water rise (compared with a control) and approximation of the proportion of oxygen in air.

(b) Carbon dioxide.

(i) The use of limewater as a test for carbon dioxide, demonstrated by bubbling carbon dioxide or breath through it.

(ii) Exposing a dish of limewater with a control dish of water beside it to test for carbon dioxide in the air.

(c) Water vapour. As in Grade 7, Unit II, Part 1 (a) (iii), exposing a glass of cold water to air to observe condensation.

(d) Solid impurities. Exposing, indoors and outdoors, plates of glass that have been lightly rubbed with oil or vaseline. Observation after several days.

Discussion of the importance or significance of each constituent.

GRADE 8. UNIT V

WEATHER

This unit should be developed through the establishment of a simple weather station, with the instruments chiefly constructed or improvised as class or individual projects. Observations made once or twice daily over a period of time will provide useful practice in record-keeping. The pupil's own results checked against the published or broadcast official readings will reveal inaccuracies or abnormal local conditions. Relating his results to the official forecasts the pupil should be able to develop the ability to make his own weather predictions.

1. WEATHER OBSERVATIONS

(a) Temperature. Observations of temperature on a Fahrenheit thermometer placed outdoors on the north side of a building or otherwise placed in a condition of 'ventilated shade'. (A maximum-minimum thermometer provides useful information, though it is not a necessity.) Daily and monthly temperature ranges. The meaning of average daily or monthly temperature.

(b) Pressure. (Unfortunately, no improvisation can give exact readings of air-pressure. A simple aneroid barometer is the cheapest instrument that will serve, and its action can be studied and easily understood.) The construction and action of a mercury barometer.

Air-pressure related to the weight of air pressing on the open end of the barometer (Unit IV, 1 (b) and (c)). The significance of changes of air-pressure. Air-pressure and elevation. The aneroid barometer as an altimeter.

(c) Wind direction. Construction and observation of a simple wind vane placed on a post away from buildings. Prevailing winds.

(d) Wind velocity. Using a simplified Beaufort scale in estimating wind-speed. Construction and use of some type of simple wind-speed indicator or a cup anemometer. Information about wind velocities in hurricanes and tornadoes.

*(e) Relative Humidity. Construction of a wet-and-dry-bulb hygrometer out of two similar thermometers, with one bulb covered with cotton and a wick leading to a dish of water. Using the differences in readings to determine from a chart the relative humidity of the air. The principle of the hygrometer related to the using of heat in the process of evaporation (Grade 7, Unit II, 1(a) (iii)). Modifications of the instrument for outdoor use in winter. The significance of relative humidity for bodily comfort and health.

Other types of humidity indicators, such as the hair hygrometer; the dial type employing a coiled strip of specially coated paper like photographic paper; colour indicators of paper soaked in cobalt chloride solution; figures emerging from a toy house by the coiling or uncoiling action of the suspending catgut string.

(f) Rainfall. Construction and observation of a simple rain gauge. Recording of weekly, monthly, and accumulated rainfall.

*(g) Snowfall. Construction and observation of a simple snow gauge or the measurement of average depth of fall from a number of readings. Conversion of snowfall to water by melting. Calculation of total annual precipitation. Other forms of precipitation — ice-pellets, hail.

*(h) Clouds. Observation of the amount of cloud cover. Identification of basic cloud types (cirrus, cumulus, stratus, nimbus). Recording of cloud types and approximate hours of sunshine on weather chart.

*2. WEATHER PREDICTIONS

(a) Simple relationships between local conditions and weather changes, such as wind direction and rainfall, cloud type and rainfall, changes in air-pressure and weather, relative humidity and weather.

(b) A study of weather maps, the movement of highs and lows and predicted weather changes.

(c) Some weather fables and their significance.

*3. CAUSES OF WEATHER CONDITIONS

(a) A map study of the earth's wind belts and discussion of their causes.

(b) Winds as parts of convection currents in relation to areas of different temperature and pressure. Land- and sea-breezes.

(c) The regular movements of high- and low-pressure areas and the movement of cold and warm air masses.

*4. WEATHER AND CLIMATE

The differences and the relations between weather and climate. The data used in statements or descriptions of climate. The ways in which weather and climate affect human activities: work, health, safety, shelter, crops and food, communications and transportation, leisure and sports, etc.

GRADE 8. UNIT VI

*PLANTS AND GARDENS

1. SOIL IMPROVEMENT

Means of maintaining or improving the fertility of the soil (i) by addition of humus, (ii) by the use of various types of fertilizers. The special requirements of different types of soil — sand, clay, loam — for their improvement. (iii) The making of a compost pile. Its value in gardening.

2. THE LAWN

The care of the lawn including levelling, fertilizing, seeding or sodding, cutting, edging, weeding.

3. ANNUAL PLANTS

The construction and use of a hotbed and a cold frame. Starting annual seeds in early spring, transferring and setting out the young plants. The difference between annuals and perennials.

4. PERENNIAL PLANTS

Planning the perennial garden in relation to such factors as soil, water, sunshine or shade requirements and the final effect depending on height and colour arrangement and period of bloom. Proper times and methods of transplanting. Winter protection.

5. ORNAMENTAL SHRUBS AND TREES

A survey of trees and shrubs of the community and consideration of their desirability for gardens or their disadvantages. Planning the garden with a view to the final effect. Consideration of time of planting, depth protection of roots, watering, pruning, supporting, winter protection.

6. THE VEGETABLE GARDEN

Planning and planting a vegetable garden.

7. SCHOOL GROUND IMPROVEMENT

Application of any of the above to the improvement and care of the school grounds.

GRADE 8. UNIT VII

SOIL

1. CHANGING ROCK TO SOIL

(a) The action of water. Examination of rounded lakeshore pebbles and streambed boulders to see the effect of waves and rivers. Grinding together two boulders held over a sheet of white paper.

(b) The action of glaciers. Examination of glacial deposits of the locality, where they have been exposed in road cuttings or gravel pits, to see the effect of grinding action of glaciers. Reference to the appearance of streams issuing from glaciers carrying fine materials.

(c) The action of freezing water. Experiment with a bottle filled with water and allowed to freeze. Experiment with a porous piece of sandstone soaked in water and allowed to freeze.

(d) Expansion and contraction with temperature changes. Examination of the boulders in a stone pile to find surface flakes broken away. Reference to the compound bar experiment (Grade 7, Unit III, 2 (d)) and application to the different rates of expansion of different rock materials.

(e) The action of gravity.

(f) The action of plants — lichens, mosses, grasses, trees, etc.

2. TRANSFER OF SOIL

(a) The carrying and sorting action of moving water. A demonstration with pebbles, gravel, and sand stirred up in a large bowl with water. The effect of water moving at different speeds to transport fine and coarse materials. Observations on sheet and gully erosion on natural slopes and the deposition of materials where the current is slowed. The sorting action of water. The grinding action of wave motion on beaches.

(b) The action of glaciers in picking up, transporting, and depositing rock and soil material. Local evidences.

(c) The action of wind. Local evidences such as blow-outs and shifting sand dunes. Sand and dust storms. The removal of sod on the western prairies facilitating wind action.

*3. SOIL TYPES

Classification of soils as clay, sand, silt, loam, and intermediate types. Experiments to show the constituents of soil

(i) by examination with a hand lens,

(ii) by separation with water (shaking up and allowing to settle in tall jar).

The special case of marshy soils and the examination of local types.

*4. SOIL PROFILE

(i) Examination of the several layers of soil exposed in a road cutting or in a post-hole. Recognition of topsoil, subsoil, and parent soil and the depths of each.

(ii) Examination of a soil map of the area.

(iii) A study of one soil type of the area, its special characteristics and uses.

5. SOIL PHYSICS

This section provides many opportunities for applying scientific methods to problems, formulating and testing hypotheses, and improvising experiments.

A comparison of several types of soils to determine some characteristics and differences in properties.

(a) The water-holding capacity of soil. Flowerpots of soil; the addition of water till it runs out of the flowerpot, run-off and absorption under differing conditions. Absorbed water retained in soil or becoming underground water, water-table, wells, underground streams, cave formation.

(b) The rise of water in soil, open-ended glass cylinders (lamp chimneys) filled with soil standing in water. The relation of the rise to the size of soil particles.

(c) The effect of mulching. Comparing weights of pots after several days, one with soil exposed, the other covered with peat moss.

(d) The presence of air in soil. Observations on pouring water into test tubes of soil.

(e) The leaching of soil. Shaking up soil with water, filtering and evaporating filtrate on watch glass.

(f) Acidity or alkalinity of soil. The use of litmus or bromthymol blue to test various types of soils.

(g) The effect of fertilizers. Experiments with several fertilizers on strips of lawn or on seeds growing in flower pots, with careful use of controls.

*6. SOIL MANAGEMENT

(a) The cause of soil loss, such as wind removal; sheet, rill, and gully erosion by water; removal of soil nutrients by crops; overcropping; excessive grazing; burning of humus materials; leaching by rain or floods; sale of topsoil; covering of topsoil in urban development, etc.

(b) Consideration of some of the following methods of improving soils or preventing their loss and depletion and the reason for their action.

Shelter belts and fencerows; use of green manures, including the ploughing in of straw and plant residues; barnyard manures; commercial fertilizers; cover crops; strip cropping; contour cultivation and cropping; grassed waterways; check dams; terracing and diversion ditches; mulch cover; composting; growth of legumes; crop rotation; proper land use; reforestation.

GRADE 8. UNIT VIII

WILDLIFE

1. CLASSIFICATION OF WILDLIFE SPECIES

(a) Birds — upland game birds (pheasant, bob-white, ruffed grouse, etc.); waterfowl (mallard and other ducks, Canada goose, etc.); raptores (hawks, owls); song birds.

(b) Mammals — game, (deer, rabbits, etc.); non-game (shrews, moles, bats, etc.); fur-bearing (beaver, otter, skunk).

(c) Fish — Game (bass, trout, pike, etc.), non-game rough (carp, etc.), commercial (herring, lake trout, etc.); others (sunfish, minnows, etc.). A survey of the locality, indicating the kinds

and relative abundance of wildlife animals. A study of some of these animals as to their mode of life, habitat, food, value, and interrelationships.

2. THE BALANCE OF NATURE

Factors limiting the abundance of any species. Interrelationships as indicated by food chains (wolves, deer, white cedar; wolves, big game, and the rabbit cycle; foxes, mice, and forest plantations; horned owls, skunks, and shrews, grasshoppers and pasture). The rôle of the predator. Pond life as an example of balance in nature. A closed terrarium or a balanced aquarium.

3. THE DEPLETION OF WILDLIFE

Consideration of the following factors: excessive hunting and fishing; destruction of habitats (fire, over-grazing, deforestation, water pollution); introduction of competing species.

Species extinct or in danger of extinction (passenger pigeon, great auk, whooping crane, etc.). Changes in the wildlife of the community deduced from the records of early settlers. Some reasons for these changes.

4. CONSERVATION OF WILDLIFE

Using one bird or fish or mammal as an example, determine how government control or government or individual action as listed below has helped in the preservation of that animal.

(a) Government Control. (Migratory Birds Protection Act, game laws, closed seasons, bag limits); (government action in restocking woods, fields, streams; establishing game reserves and wildlife sanctuaries; research); (the work of local conservation authorities).

(b) Individual action (bird houses, shelters, and feeding stations; farm practices to encourage wildlife; protection of forests and waterways; preservation of natural habitats).

GRADE 9. UNIT I

SOUND

1. THE PROPAGATION OF SOUND

(a) Experiments on sounds produced in a vacuum and in air.

(b) Experiments to test the transmission of sound through water, wood, iron, rocks.

(c) Historical reference to determination of the velocity of sound in air, velocity of sound in water.

(d) Cause of echoes.

(e) Simple problems.

2. SOUND WAVES

(a) Experiments with vibrating bodies.

(b) Demonstrations with a coiled spring to illustrate the terms *restoring force, amplitude, period, frequency, vibration.*

(c) Discussion of sound as due to the vibration of the molecules of the air.

*(d) The pendulum.

3. CHARACTERISTICS OF SOUND

(a) Intensity (loudness) (i) Its dependence on the amplitude of the vibrating source and the distance from the source (qualitative treatment only). (ii) Reference to the decibel scale.

(b) Pitch (i) Experiment with Savart wheel to establish relation with frequency. *(ii) Limits of audibility to the human ear. Dog whistle, Bat squeak.

(c) Quality (i) Recognition that sounds emanating from piano, violin, organ pipe, tuning fork differ in quality. (ii) Differences in violin string plucked or bowed and in tuning fork bowed or struck with metal hammer. *(iii) Reference to overtones.

GRADE 9. UNIT II

MEASUREMENT

1. THE METRIC SYSTEM

(a) The standard metre, kilogram, litre.

(b) Significance of the prefixes with emphasis on *milli-*, *centi-*, and *kilo-*, as most commonly used.

(c) Common derivatives and their abbreviations; relations as decimal fractions. Square and cubic measure.

(d) Relation between kilogram and pound, litre and quart, centimetre and inch.

2. PRACTICE IN MEASUREMENT

(a) Measuring lengths; calculating areas and volumes from measurements.

(b) Measuring volumes of liquids with graduated cylinder or burette. The meniscus.

(c) Practice in the use of the balance. Mass.

(d) An appreciation of the degree of accuracy of measurement and of significant figures.

3. DENSITY

(a) Meaning of density as mass per unit volume (under stated conditions).

(b) Experimental determination of density of solids, regular and irregular, finding the volume by several methods.
*Using the volume of a substance of known density to determine the mass.

(c) Experimental determination of the density of liquids such as water, carbon tetrachloride, or mercury.

*(d) Meaning of specific gravity. Its relationship to density.

*(e) Experiments to measure buoyancy. Archimedes' Principle, Hydrometers.

4. PRESSURE

(a) Meaning of pressure as force per unit area.

(b) Experiments on the relation between pressure in a liquid and depth.

(c) Experiments on the direction of pressure in a liquid.

(d) Calculation of pressure in a liquid.

(e) Air-pressure. Construction and principle of a mercury barometer. The aneroid barometer. Application of air-pressure in (i) drinking straw, (ii) water pump, (iii) fountain pen, (iv) siphon.

5. TEMPERATURE

(a) Fahrenheit, Celsius (Centigrade), and Kelvin (Absolute) scales. The different numbers attached to the fixed points of freezing and boiling water. The uses of the three scales.

(b) Conversion of temperature values from one scale to another.

*(c) The difference between temperature and quantity of heat. Meaning of *calorie* and *B.T.U.* Simple experiments and calculations on heat transfers. (This topic will receive more extensive treatment in Grade 10, Unit V).

SOLIDS, LIQUIDS, AND GASES

1. CHANGES OF STATE

(GRADE 7, UNIT II, 1)

(a) The three states of matter and their characteristics.

(b) Experiments on the changes occurring during melting, solidification (freezing), vaporization, condensation, sublimation, using some of the following substances: water, paraffin wax, mercury, moth flakes, iodine crystals, dry ice.

(c) Experimental determination of the boiling point of water. The reason for the stationary temperature as the water boils.

(d) Experiment to find the effect of changes in pressure on the boiling point of water.

(e) Experiment to find the effect of evaporation on the temperature of a liquid. The hygrometer. Refrigeration processes.

(f) Discussion of the production of rain, clouds, and dew by condensation.

*(g) Discussion of the changes of volume and the energy changes involved in changes of state; the molecular theory related to these phenomena.

2. WATER

(GRADE 7, UNIT II, 1)

(a) The distribution and importance of water in its three states.

(b) Experiments on physical properties, including freezing point, boiling point, and density.

*Experiments on the anomalous volume change in water below 4°C and on freezing.

(c) (i) Experiments on water as a solvent.

(ii) The effect of temperature change on solubility as in the formation of a solution of copper sulphate.

(iii) The terms *solvent, solute, solution, solubility, unsaturated* and *saturated solutions.*

(iv) The effect of filtration on dissolved and suspended materials.

(v) The effect of distillation on dissolved and suspended materials.

(d) Experiments on the comparative solubilities of several substances, such as common salt, sugar, copper sulphate, chalk. Various methods of stating solubility. Solubility curves.

*(e) Experimental study of other types of solutions, such as liquids in liquids, gases in liquids.

*(f) The composition of water as illustrated by electrolysis (no explanation in terms of ions to be required). Some of the physical and chemical properties of hydrogen.

3. AIR

(GRADE 8, UNIT IV)

(a) An experiment to illustrate the laboratory preparation, collection, and some of the physical and chemical properties of oxygen, including the burning in oxygen of charcoal, sulphur, and iron.

(b) An experiment to determine the percent of nitrogen in the air and some of the physical and chemical properties of nitrogen.
*Priestley, Lavoisier, the phlogiston theory, uses of nitrogen.

(c) An experiment to illustrate the laboratory preparation, collection, and some of the physical and chemical properties of carbon dioxide. Reference to testing for carbon dioxide in air and in the breath. (See Grade 8, Unit IV.)

(d) Reference to the variable quantity of water vapour in the air.

(e) Reference to the presence of small quantities of other gases in the air.

GRADE 9. UNIT IV

BIOLOGY: THE CELL

1. THE MICROSCOPE

(a) Discussion of the contributions of Hooke, van Leeuwenhoek, Schleiden and Schwann to the development of the microscope and of the Cell Theory.

(b) Manipulation of the microscope.

2. STRUCTURE OF PLANT CELLS

(a) Microscopic examination of plant cells. Description and use of cell-wall (non-living); cytoplasm (water, granules, food); nucleus; vacuole (non-living); chloroplast; mitochondria; membranes surrounding the nucleus and vacuole and that lining the cell-wall. The term *protoplasm* should be used to include all the living material in the cell.

(b) Microscopic examination of a chlorophyll-bearing cell (elodea) and a non-chlorophyll-bearing cell (yeast or onion) to show as many of the structural features as possible.

3. STRUCTURE OF ANIMAL CELLS

(a) Comparison of plant and animal cells with emphasis on the following differences: (i) non-living cell-wall found in plant cells is absent in animal cells; (ii) many plant cells contain chloroplasts, which are normally lacking in animal cells.

(b) Microscopic examination of such animal cells as epithelial cells scraped from the lining of the pupil's mouth.

4. REPRODUCTION OF A CELL

Division of the nucleus (discussion of mitosis is not required). Division of the cell. Growth of the daughter cells.

5. ORGANIZATION OF CELLS

Organization of cells into tissues (muscle, nerve); of tissues into organs (stomach, eye, leaf, root); of organs into systems (digestive, respiratory); of systems into organisms (plant, animal).

6. FUNCTIONS OF A CELL

Consideration of a cell as a living unit requiring energy to carry on its life processes.

(a) Photosynthesis — the production of food (containing stored energy) by chlorophyll-bearing cells.

(i) Experiment to test for starch in a slice of potato by adding iodine solution.

(ii) Experiment to test for starch in chlorophyll-bearing cells kept in darkness for a considerable time and again after exposure to light.

(iii) Experiment to test for oxygen production by chlorophyll-bearing cells.

The dependence, directly or indirectly, of all plants and animals upon the photosynthetic process for obtaining energy.

(b) Respiration — a process occurring in all living cells by which energy is released. (Breathing is a mechanical process by which certain materials are inhaled and others are exhaled.)

(i) Experiments on the processes of the living cell, in relation to oxygen, carbon dioxide, water, and the release of energy.

Comparison of respiration and photosynthesis with respect to time, place, required materials, products, energy transformations. Word equations.

(c) Diffusion and Osmosis.

(i) Experiment to show movement of particles between regions of different concentration (with and without a membrane). It should be noted that living plasma membranes are differentially permeable or selective.

(ii) Osmosis — the passage of water through a differentially permeable membrane from a region of high concentration of water to one of low concentration. Experiments on osmosis.

GRADE 9. UNIT V

BIOLOGY: INVERTEBRATES

(See Grade 8, Unit II, 1, 2.)

1. THE AMOEBA

An animal that performs all the essential life processes within a single cell.

(a) Microscopic examination of the living amoeba to see its parts and to study their functions; cytoplasm (ectoplasm, endoplasm), nucleus, contractile vacuole, food vacuole.

(b) Discussion of locomotion, feeding, breathing and respiration, excretion, and reproduction in the amoeba.

2. THE CRAYFISH

A multi-cellular organism. A study, related as far as possible to living specimens, of (a) Habitat, (b) Covering and segmentation, (c) Body divisions: dissection to study the structure and function of the following:

(i) Cephalothorax — eyes, antennae and antennules, mouth parts, legs, including chelipeds, gills;

(ii) Abdomen — swimmerets, uropods, and telson;

(d) Regeneration of lost parts; (e) Serial homology as illustrated by legs, swimmerets, and uropods; (f) Breathing and respiration — use of gills, swimmerets, and gill bailers in breathing; respiration in cells, (g) locomotion, (h) life history, (i) recognition of other members of the class, (j) characteristics of the class Crustaceae.

3. INSECTS

(N.B. In choosing insects for study, an attempt should be made to avoid those which have been studied in earlier grades by any large proportion of the pupils.)

(a) A study of the dragonfly or cricket as an example of an insect with a biting and chewing mouth and incomplete metamorphosis.

(b) A study of the ichneumon fly or monarch butterfly as an example of an insect with a sucking mouth and complete metamorphosis.

The insects selected in (a) and (b) should be examined to study the body divisions, the structure and function of the exoskeleton, eyes, antennae, mouth parts (dissection is not required), legs, wings, spiracles, ovipositors.

(c) Breathing and respiration — discussion of the rôle of spiracles, tracheae, and tracheoles in conveying oxygen to, and carbon dioxide from, the cells of the body without the aid of a well-developed circulatory system. Examination of a trachea (or a prepared slide of it) with a microscope.

(d) Life history of *one* of the insects studied.

(e) Methods of controlling injurious insects: (i) natural means — predators, climate; (i) artificial means — food and contact poisons.

(f) Reason for the numerical superiority of insects over all other animals — size, locomotion, colour, eyes, breathing organs, length of life history, number of offspring.

***4. INSECTS**

Characteristics of the class Insecta and the names and characteristics of the orders of insects studied.

***5.**

Very brief discussion of other invertebrates: spider, earthworm, clams.

GRADE 9. UNIT VI

BIOLOGY: VERTEBRATES

(See Grade 8, Unit II, 3.)

1. FISH

(a) An introductory discussion of the fish and its habitat, with special reference to the different levels at which fish live.

(b) Observation of living fish in an aquarium, to study locomotion, balance, and breathing.

(c) Examination of a preserved specimen of perch to study shape, body divisions, body covering, eyes, nostrils, mouth, gill covers, gills (dissection), fins, lateral line, scales, tail.

(d) Breathing and respiration — discussion of breathing with special reference to water movement into, and out of, the mouth cavity and the gaseous exchanges involved. Discussion of the rôle of

the circulatory system in carrying oxygen to the cells of the body (where respiration occurs) and in removing of carbon dioxide.

(e) Life history — production of many eggs, external fertilization, lack of parental care, high mortality, importance of yolk sac.

*(f) Identification of several common types of fish. Recognition of the characteristics of the class Pisces.

2. FROG

(a) Habitat.

(b) Examination to study body divisions, body covering, eyes and eyelids, nares, ears, mouth, legs and feet.

(c) Feeding habits.

(d) Breathing and respiration

(i) in the tadpole — external and internal gills;

(ii) in the adult — the rôle of the skin, mouth, lungs, and circulatory system.

(e) Life history — special mention of the egg mass, external fertilization, and the frog's amphibious nature.

*(f) Identification of toads, newts, salamanders, and mud puppies. Recognition of the characteristics of the class Amphibia.

3. SNAKE

(a) Habitat.

(b) Examination to study body covering, eyes, nostrils, mouth.

(c) Feeding habits — adaptations for swallowing large objects.

(d) Breathing and respiration.

(e) Locomotion.

(f) Reproduction.

*(g) Identification of other reptiles (turtles, crocodiles, alligators, lizards). Reference to extinct forms. Recognition of the characteristics of the class Reptilia.

4. BIRD

(a) Examination to study shape, scales, feathers (modified scales), eyes and eyelids, ears, nostrils, beak and mouth, wings, and legs.

(b) Structure and uses of contour, quill, and body feathers, down feathers and pin feathers.

(c) Feeding — absence of teeth; structure and use of gizzard (dissection).

(d) Breathing and respiration — description and use of the breathing organs, with reference to the specialized nature of the lungs, air sacs, and hollow bones. Movement of the breast bone and of the back bone (when flying). Efficient circulatory system carrying oxygen to the cells for respiration.

(e) Adaptations for flight — shape, feathers, breathing, lightness of bones, fusion of wing bones, shape of wings and tail.

(f) Reproduction — internal fertilization before shell is formed. Small number of eggs. Parental care.

GRADE 9. UNIT VII

BIOLOGY: MAN

1. INTRODUCTORY

Discussion of man as a vertebrate animal with special reference to characteristics, such as well-developed brain (high intelligence), erect posture, opposable thumb, hair, mammary glands.

2. NUTRITION

(a) Processes involved — securing food, digestion, building protoplasm.

(b) Types of food and their uses:

(i) carbohydrates and fats as energy producers,

(ii) proteins as tissue builders,

(iii) vitamins and minerals as protective foods, (Detailed study of vitamins not required.)

(iv) water as a medium for conduction and as the most abundant constituent of the body (70%).

(c) General plan of the human digestive system and the use of each part.

(d) Enzyme action in the processes of digestion.

(i) Experiments to test for the presence of starch and of a reducing sugar in foods;

(ii) Experiment on the action of saliva on starch. Brief discussion to show that enzymes convert fats, proteins, and complex carbohydrates into soluble compounds capable of being absorbed. (Names of enzymes not required.)

(e) Absorption. Adaptation of the small intestine for absorption of digested food — great length, villi, concentration of blood vessels.

3. CIRCULATION

(a) The need for a circulatory system.

(b) Structure and use of the heart, arteries, veins, and capillaries.

(c) Composition of blood.

(d) Flow of blood through the pulmonary and systemic systems (names of vessels not required) and changes in its composition.

(e) Observation of blood flowing through the web of a frog's foot or the tail of a fish.

4. BREATHING AND RESPIRATION

(a) The breathing organs and their uses.

(b) The mechanics of breathing. An experiment to demonstrate it.

(c) The relationship of the respiratory to the circulatory system.

(d) The necessity of cellular respiration.

5. EXCRETION

(a) Meaning of excretion.

(b) Excretion by means of the skin, kidneys, ureters, and urinary bladder. (Structure of kidneys not required.)

6. REPRODUCTION

Development of the young within the body, nourishment and parental care of young, small number of offspring, relatively low mortality rate.

*7. **IDENTIFICATION OF OTHER MAMMALS,** mentioning bats and whales. Characteristics of the class Mammalia.

AGRICULTURAL TOPICS FOR SCHOOLS IN WHICH AGRICULTURAL SCIENCE IS TAUGHT

(a) Assignment of Home Projects during the year.

(b) Planting bulbs in the fall for indoor winter bloom.

(c) The Babcock test for fat in whole milk. Value of this test in payment to producers for milk.

(d) Water in relation to soils. Water table. Hygroscopic, gravitational, and capillary water. Experiments with sand, clay, humus, or muck soils to show air space, capillary capacity. (Rise of water in soils). Conservation of moisture by mulches and cultivation.

BOTANY: FLOWERING PLANTS

1. GENERAL STRUCTURE OF THE PLANT

(N.B. Portions of some of the topics in this unit have been taken in Grade 8, Unit I. Teachers should avoid the unnecessary repetition of familiar introductory material. They should also try to select for detailed examination flowers, fruits, and seeds that have not been studied in earlier grades.)

(a) A practical study and examination of a buttercup (or mustard), a toadflax (or snapdragon) and a composite flower such as chicory, burdock, sunflower, under the following headings:

- (i) Root — kind of root system;
- (ii) Stem — texture (woody or herbaceous); habit of growth;
- (iii) Leaf — simple or compound; venation; arrangement;
- (iv) Flower — description; cohesion (relationship of like parts) and adhesion (relationship of unlike parts) of the sepals of the calyx, of the petals of the corolla, of the stamens, and of the carpels of the pistil; comparison of ray and disc florets in the head of a composite flower.
- (v) Fruit — description.

(b) The occurrence of flowers and fruits on

- (i) Grass plants — oats, red top grass;
- (ii) Deciduous trees — maple, willow;
- (iii) Coniferous trees — pine, spruce.

2. POLLINATION

(a) Reference to definition, types, and agencies as developed in Grade 8, Unit I.

(b) Adaptations to ensure cross-pollination — preference for foreign pollen; dioecious plants; time of maturation of essential organs.

(c) Microscopic examination of pollen.

3. FERTILIZATION

(a) The development of the pollen tube from the pollen grain.

(b) The development of an ovule prior to fertilization.

(c) The union of male and female nuclei to form the zygote and endosperm.

4. **SEEDS**

(a) The development of seeds from fertilized ovules.

(b) Examination of a bean or pea seed to study its structure and the origin and uses of its parts.

(c) Observation of the stages in the germination of a bean or pea seedling.

(d) The uses of seeds, e.g., sexual reproduction and the development of new varieties; carrying the plant through a period of unfavourable conditions (dry or cold weather); increasing the number of offspring.

5. **FRUITS**

(a) Definition — a ripened ovary containing seeds. Other parts such as the receptacle, calyx, stigma, or style may form part of the fruit.

(b) Kind

(i) Simple fleshy fruits — examination of a plum or peach (drupe), apple or pear (pome), a tomato or grape (berry);

(ii) Simple dry dehiscent fruits — examination of a legume;

(iii) Simple dry indehiscent fruits — examination of a nut (acorn) and a caryopsis (corn or wheat), noting that a corn or wheat kernel is a fruit with a seed fused to the ovary wall;

(iv) Aggregate fruits — a raspberry;

(v) Multiple fruits — a pineapple.

6. **VEGETATIVE AND SEXUAL REPRODUCTION**

(a) The advantages of each type of reproduction.

(b) Vegetative reproduction from stems (including subterranean stems) and leaves.

(c) Cleft grafting and budding — the methods used and the advantages of the processes.

7. **STRUCTURE OF A WOODY STEM**

(a) Examination of stems to distinguish bark (cork and phloem), cambium, xylem (heartwood and sapwood), rays, pith; their position and uses.

(b) The cause and significance of annual rings.

(c) The cause of graining in wood; the cause of knots.

(d) Microscopic examination of a cross-section of a stem.

8. STRUCTURE OF A LEAF

(a) Microscopic examination of a cross-section of a leaf and of the surface view of the epidermis.

(b) Position, description, and uses of the cuticle, epidermis, guard cells, stomata, palisade, and spongy parenchyma, chloroplasts, veins.

(c) The function of the guard cells in controlling the rate of transpiration. Comparison of deciduous and evergreen trees in the shedding of leaves in various climates.

GRADE 10. UNIT II

BOTANY: NON-FLOWERING PLANTS

1. FUNGUS PLANTS

(a) General characteristics compared with chlorophyll-bearing, flowering plants.

(b) Mushroom.

- (i) Examination to show the structure of each part, their functions;
- (ii) Method of obtaining food;
- (iii) Method of reproduction —spores and mycelium;
- (iv) Edible and poisonous mushrooms compared.

(c) Bread-mould.

- (i) Laboratory growth of some bread-mould;
- (ii) Microscopic examination to identify mycelium, hyphae, sporangium, and spores.
- (iii) Importance and uses of moulds — decomposition of waste; medicinal products.

(d) Yeast.

- (i) Laboratory growth of yeast in a sugar solution;
- (ii) Microscopic examination of yeast cells;
- (iii) Methods of reproduction — budding, spores;
- (iv) Experiment to collect and identify the gas produced by yeast in sugar solution;
- (v) Economic importance of yeasts — fermentation processes, bread-making.

(e) Apple Scab fungus.

- (i) Examination of an affected fruit and of the leaves of its host, to note its appearance and effects;
- (ii) Life history — winter and summer stages;
- (iii) Economic importance and methods of control.

(f) Other fungous diseases —
Brief discussion of athlete's foot, smuts, rusts, mildews, and blights.

(g) Classification of fungi as parasitic or saprophytic.

2. BACTERIA

(a) Laboratory culture of bacterial colonies on a suitable medium.

(b) Structure of a bacterium.

(c) Bacterial shapes — bacillus, coccus, spirillum.

(d) Economic importance.

(i) Harmful bacteria — food spoilage, diseases;

(ii) Useful bacteria — soil fertility, decomposition of organic matter, legume bacteria, nitrogen cycle; bacteria in a septic tank; other uses: making vinegar, sauerkraut, sour milk, cheese.

(e) Control of Bacteria.

(i) Harmful to foods — pasteurization, refrigeration, dehydration, chlorination, sterilization by heat or chemicals, smoking meat, sugar in canning, brine in pickling;

(ii) Harmful to plants — use of fungicides;

(iii) Harmful to animals — immunization, antibiotics, antiseptics.

3. VIRUSES

The uncertainty of their classification as living organisms. Developing only in living cells. Importance in plant and animal diseases, e.g., tobacco virus, smallpox.

4. LICHENS

(a) Recognition and habitat.

(b) Examination to show structure, noting the symbiotic nature of a lichen, and the function of each symbiont.

(c) The rôle of lichens in changing rock into soil.

5. FERNS

A study of bracken or some other fern to include

(a) Recognition and habitat.

(b) Examination of the sporophyte — roots, rhizome stem, frond consisting of rachis, pinnae, pinnules, sori (sporangia containing spores).

(c) Reproduction noting only that the spores produce an inconspicuous sexual generation, which in turn produces the sporophyte.

GRADE 10. UNIT III

BOTANY: HEREDITY AND ENVIRONMENT

1. HEREDITY

Most of the important characteristics of a plant are determined when fertilization occurs. The offspring receives factors or determiners of characteristics from both parents. Reference to Mendel's experiment with tall and dwarf peas. Discussion of a simple example of a monohybrid cross.

2. ENVIRONMENT

The possible effects on the development of a plant arising from the following environmental factors:

(a) Climate — precipitation, temperature, light.

(b) Soils — mineral content, porosity.

(c) Other animals and plants — competition for light, water, and minerals; destruction of plants by animals; parasitic diseases; symbiosis; artificial pollination of plants by man.

3. PLANT COMMUNITIES AND SUCCESSION OF COMMUNITIES

(a) definitions.

(b) examples of communities — algae, water-lily, willow, maple and beech.

(c) change from one type of community to another.

GRADE 10. UNIT IV

FORCE, WORK, ENERGY, POWER

This unit should be illustrated by simple experiments and demonstrations, wherever possible.

1. FORCE

(a) Examples of force involving gravity, magnets, wind, muscles, springs, explosions.

(b) Relation of force to motion. Newton's First Law.

(c) Units of force — pound, gram.

(d) The difference between mass and weight.

(e) The rôle of friction.

2. WORK

(a) The meaning of work.

(b) Measurement of work done when a body is raised.

(c) Units of work — foot-pound and gram-centimetre.

(d) Simple problems.

(e) The lever in terms of force and work. Mechanical advantage. Moment of a force.

3. ENERGY

(a) Definition of energy. Kinds of energy.

(b) Simple illustrations of transformation of energy.

(c) The law of Conservation of Energy — the evidence on which such a generalization is based.

(d) Energy transformations in

(i) The hydro-electric system,

(ii) The automobile,

(iii) The sun,

(iv) The hydrogen bomb.

4. POWER

(a) Definitions of power and horsepower.

(b) Measurement of horsepower, e.g., a person walking or running up stairs.

(c) Simple problems.

GRADE 10. UNIT V

HEAT

This unit should be illustrated by simple experiments and demonstrations, wherever possible.

1. HEAT AS A FORM OF ENERGY: production by transformation from other forms of energy. Experiments to illustrate some of these transformations.

2. MEASUREMENT OF HEAT

(a) The calorie and the British Thermal Unit as measures of heat.

(b) Measurement of the quantity of heat absorbed or released when the temperature of a given mass of water is altered.

(c) Simple problems.

(d) Conversion of calories to B.T.U.'s.

3. HEAT CAPACITY

(a) Simple experiments to compare the heat capacities of different substances; the significance of the high heat capacity of water in relation to climate.

(b) Definition of Specific Heat.

Experiment to measure the specific heat of a solid (omitting from consideration the water equivalent of the container). Simple problems.

4. CHANGE OF STATE WITH ADDITION OR REMOVAL OF HEAT

Measurement of temperature while ice melts or water boils; the use of ice in refrigeration and of steam in heating.

5. HEAT OF FUSION

The amount of heat (energy) required to melt a unit mass of a substance. Experiment to measure the heat of fusion of ice. Simple problems.

6. HEAT OF VAPORIZATION

The heat of vaporization of water. Simple problems.

**Problems involving two or more of the concepts *specific heat, heat of fusion, heat of vaporization.*

N.B. Transformations of energy in changes of state as related to molecular theory are illustrated in the film, "Molecular Theory," available from the Audio-Visual Branch, Department of Education.

GRADE 10. UNIT VI

LIGHT

This unit should be illustrated by simple experiments and demonstrations, wherever possible.

1. TRANSMISSION OF LIGHT

(a) Sources of light in several transformations of energy.

(b) Investigating whether a material medium is necessary in the propagation of light.

(c) Demonstration of rectilinear propagation of light. Experiment on the formation and characteristics of the image formed in a pin-hole camera.

(d) Discussion of the velocity of light.

2. REFLECTION OF LIGHT

(a) Experiments with plane mirrors to develop the laws of reflection of light and to show the paths of light to the eye.

(b) Regular and diffuse reflection illustrated by a light beam directed against a wall and against a mirror. Direct and indirect lighting.

*(c) Demonstrations, using a concave mirror, of

(i) focusing of parallel rays,

(ii) the production of a real image.

3. REFRACTION OF LIGHT

(a) Demonstration of the refraction of light using

(i) air and water,

(ii) air and glass.

(b) Explanation by means of waves.

(c) Experiments to trace the path of light through

(i) a rectangular glass prism,

(ii) a triangular glass prism.

4. COLOUR

(a) Experiments to show the formation of the spectral hues from white light and the formation of white light from the spectral hues.

(b) The reflection and absorption of light as related to the colour of objects.

*(c) Complementary colours; the mixing of pigments.

GRADE 10. UNIT VII

ELECTRICITY

1. STATIC ELECTRICITY

(a) Experiments on the electrification of substances — ebonite rubbed with fur, glass rubbed with silk.

(b) Experiments to distinguish two kinds of electrification.

(c) Experiments on electrical attraction and repulsion.

(d) Examination of the structure and function of the metal leaf electroscope.

(e) Experiments on electrification by induction. Shielding.

(f) Experiments to identify conducting and insulating substances.

(g) The movement of electrons as illustrated by sparks.

*(h) Electrification of various substances with reference to difference in potential.

*(i) Explanation of electrification in terms of the structure of the atom, with reference to a positively-charged nucleus surrounded by electrons.

2. CURRENT ELECTRICITY

(a) The idea of current electricity as a flow of electrons in a solid (conductor).

(b) Experiment on the presence of a magnetic field about a conductor in which there is an electron flow (Oersted's experiment).

(c) Experiment on the use of a compass needle to detect an electron flow and to distinguish its direction.

(d) Experiment to show the nature and form of the magnetic field about a conductor in which there is an electron flow (using iron filings).

(e) Experiments to develop the rule for determining the direction of the electron flow.

(f) The electromagnet and some of its applications.

(g) The electric circuit. Experiments to show series and parallel circuits. *Domestic circuits.

(h) Experiments on the heating effect of an electron flow. Transformation to heat and light (toaster, incandescent lamp).

(i) Experiment to show a "short circuit" as evidence of electrons following the path of least resistance. The fuse.

(j) Electrical units — coulomb, ampere, volt, watt, kilowatt-hour.

(k) Simple problems.

GRADE 10. UNIT VIII

CHEMICAL ENERGY

1. PHOTOSYNTHESIS

(a) Reference to photosynthesis as a means of transforming radiant energy into chemical potential energy.

(b) Reference to the transformation of energy in a cell illustrating the use of foods in supplying energy. The caloric value of foods.

2. THE VOLTAIC CELL

(a) The voltaic cell as a means of transforming chemical potential energy into electrical energy.

(b) Experiments to show the structure and function of the voltaic cell. Explanation of the course and flow of electrons.

(c) Other types of batteries and storage cells.

3. OXIDATION

Oxidation as a means of releasing energy in various forms, e.g., heat, light.

(a) Experiments to show the part that oxygen plays in the burning process.

(b) Experiments with burning magnesium, sodium, phosphorus, to show differences in the properties of reactants and resultants such as state, colour, odour, solubility and nature of solution, energy content.

(c) The flame, its structure and composition, illustrated by the bunsen burner or the candle.

(d) Experiment to determine the products formed by bunsen burner or candle flame or the burning of other fuels. Differences in energy released. The caloric value of fuels.

(e) The meaning in relation to oxidation of burning, low temperature oxidation, ignition temperature, spontaneous combustion.

(f) The structure and action of a match.

*4. NUCLEAR REACTIONS

Nuclear reactions as a source of various forms of energy; the sun, atomic fission, etc.

AGRICULTURAL TOPICS FOR SCHOOLS IN WHICH AGRICULTURAL SCIENCE IS TAUGHT

(a) Incubation and examination of the developing chick. Care of baby chicks during one or more weeks after hatching.

(b) Method and value of candling eggs.

(c) The composition of milk.

(d) Beekeeping. Parts of the hive. The colony — queen, drone, and worker. The importance of honey as a food.

NOTE: Teachers should note that much of the work in zoology requires the use of preserved specimens. If animals are used as teaching aids in the classroom, they must not be put to death in the presence of students. Living animals must not be used in any experiment or demonstration involving pain, distress, or suffering.